

Advanced Analytical Tools for the Characterization of Fundamental Jet Noise Sources and Structures, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)



ABSTRACT

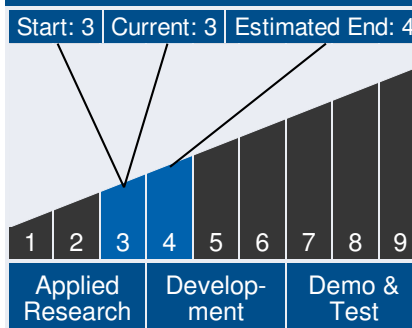
There is a need for innovative technologies and methods for noise reduction, noise prediction, and noise diagnostics. A comprehensive approach to reducing noise from any flow is predicated on a clear understanding of noise sources, i.e., the turbulent flow itself. Although much has been discovered in the last several decades about the connection between turbulence and noise, the heuristic element of the analysis has prevented the development of breakthrough noise mitigation technologies. For example, it is known that larger structures are responsible for shallow-angle noise, and the formation of shocks at supersonic speeds results in a new mechanism of noise production due to the passage of turbulent structures. However, the precise mechanism by which this transformation occurs is not known. High-fidelity datasets that capture the above phenomena whether from simulation or experiment are increasingly accessible, and need to be harnessed in better ways. With this in mind, analytical tools must be used and developed to extract the most useful information from the data. Tool such as Proper Orthogonal Decomposition, Stochastic estimation, Wavelet decomposition, Empirical Mode Decomposition, Dynamical Mode Decomposition and Doak's decomposition have been shown to be useful for extracting such information. At present however, different practitioners use these tools differently, which makes the task of assimilating the data very difficult. The goal of the present effort is to develop a user-friendly software suite that unifies these advanced techniques to provide a standard approach. The development will be integrated with testing by exploring noise sources in ongoing experimental and computational rectangular and an axisymmetric multi-stream jet campaigns.



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Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

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ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The Technical Objectives presented in this proposal are directly addressing the A1.02 Quiet Performance subtopic description by characterizing fundamental noise sources for subsonic and supersonic three-stream engine nozzle. The understanding of these fundamental source can then be exploited to help designers develop quieter propulsion systems. We particularly address the need for innovative source identification techniques for noise sources including turbulence details related to flow-induced noise typical of jets, shocks, vortices, shear layers, etc. In addition, the developed toolkit could be used by NASA to help process their data. This would allow NASA to perform the analyses on their data and characterized noise source from any new new nozzle design. The analyses are also broader that noise, they can be applied to other fluid dynamic data sets in an attempt to extract information.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The knowledge gained from this study will additionally impact the DOD and engine makers such as General Electric and Pratt and Whitney. These organizations when doing nozzle design can use the information leading to design guidelines for quieter performance. Aircraft manufacturing companies such as Lockheed Martin and Northrop Grumman also may use guidelines from this work to help develop nozzle for embedded propulsion systems. In addition, the tools used and developed as part of this research have a much broader application then just jet noise. The tools can be used in must turbulence related studies to help identify important flow features. As such, the tools can be distributed to universities, industry, and the DOD.

Management Team (cont.)

Program Manager:

- Carlos Torrez

Principal Investigator:

- Sivaram Gogineni

Technology Areas

Primary Technology Area:

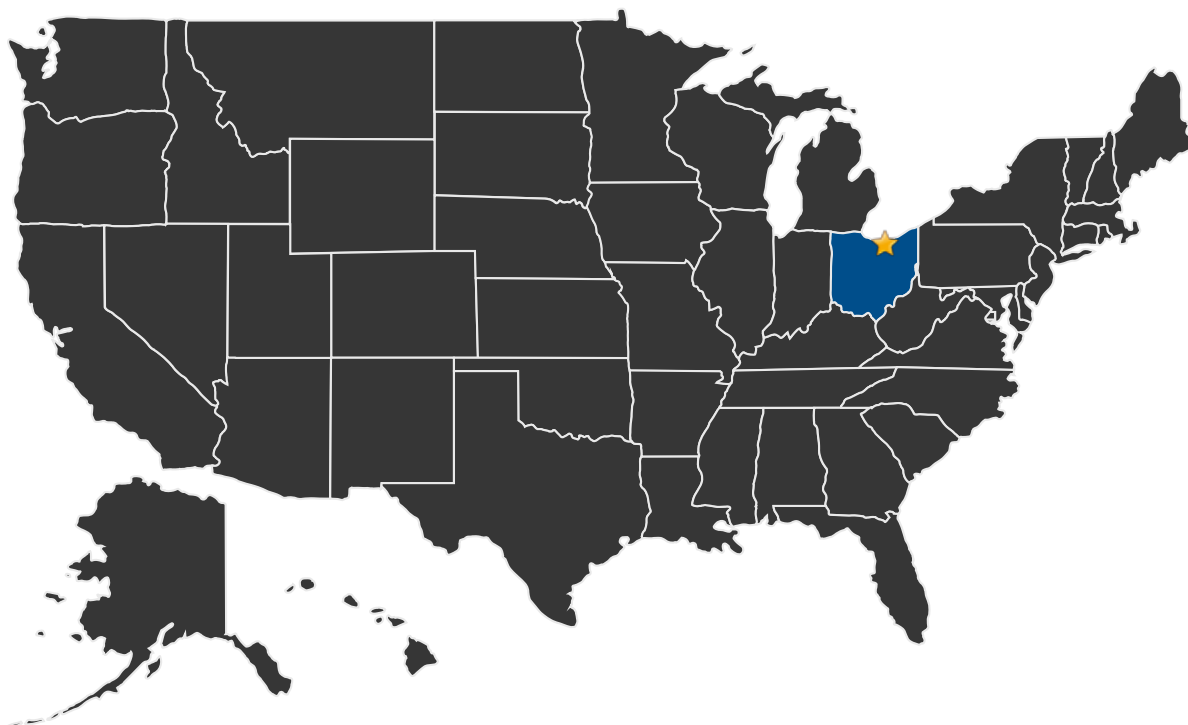
Launch Propulsion Systems (TA 1)

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U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States With Work ★ **Lead Center:**
Glenn Research Center

Other Organizations Performing Work:

- Spectral Energies, LLC (Dayton, OH)

PROJECT LIBRARY

Presentations

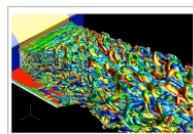
- Briefing Chart
 - (<http://techport.nasa.gov:80/file/23209>)

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IMAGE GALLERY



Flow structures in a three-stream rectangular nozzle with a deck

New field model of the jet produced by a three-stream engine nozzle used to help generate a low-dimensional noise prediction tool (Qian et al.)

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DETAILS FOR TECHNOLOGY 1

Technology Title

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Potential Applications

The Technical Objectives presented in this proposal are directly addressing the A1.02 Quiet Performance subtopic description by characterizing fundamental noise sources for subsonic and supersonic three-stream engine nozzle. The understanding of these fundamental source can then be exploited to help designers develop quieter propulsion systems. We particularly address the need for innovative source identification techniques for noise sources including turbulence details related to flow-induced noise typical of jets, shocks, vortices, shear layers, etc. In addition, the developed toolkit could be used by NASA to help process their data. This would allow NASA to perform the analyses on their data and characterized noise source from any new new nozzle design. The analyses are also broader that noise, they can be applied to other fluid dynamic data sets in an attempt to extract information.